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ABSTRACT

Western Michigan University has completed a one-year energy conservation project in which a campus-wide steam trap survey and maintenance program was implemented. The university uses purchased steam energy generated from coal to provide heating and other system requirements to approximately 6 million square feet of campus buildings through a ten-mile network of buried steam and condensate lines. Nearly 4,800 steam traps were surveyed under the program, with 22% of these identified as "failed" and wasting energy. The failed traps were replaced, resulting in an annual energy savings to the university of nearly 100 million pounds of steam, over 10% of the annual usage, and a cost avoidance of nearly $400,000. The total cost to complete the program was $169,100. The survey portion of the program involved generation of a computerized database of all surveyed traps. The program, a powerful management and planning tool, compiles all the information gathered in the field, ranging from pipe size to trap type and application in an easy-to-use program. The project was an unqualified success, exceeding its goals, and funds have been committed for its continuation. (Author/MSE)

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WESTERN MICHIGAN UNIVERSITY

1989 STEAM TRAP SURVEY & MAINTENANCE PROGRAM

APRIL 1, 1989 TO FEBRUARY 15, 1990

HE023659

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AASCU/ERIC Model Programs Inventory Project

The AASCU/ERIC Model Programs Inventory is a two-year project seeking to establish and test a model system for collecting and disseminating information on model programs at AASCU-member institutions--375 of the public four-year colleges and universities in the United States.

The four objectives of the project are:

- To increase the information on model programs available to all institutions through the ERIC system
- To encourage the use of the ERIC system by AASCU institutions
- To improve AASCU's ability to know about, and share information on, activities at member institutions, and
- To test a model for collaboration with ERIC that other national organizations might adopt.

The AASCU/ERIC Model Programs Inventory Project is funded with a grant from the Fund for the Improvement of Postsecondary Education to the American Association of State Colleges and Universities, in collaboration with the ERIC Clearinghouse on Higher Education at The George Washington University.

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1.0 ABSTRACT

Western Michigan University recently completed a one-year energy conservation project in which they implemented a campuswide steam trap survey and maintenance program beginning in April, 1989. Western utilizes purchased steam energy generated from coal to provide heating and other system requirements to approximately 6 million square feet of campus buildings through a ten mile network of buried steam and condensate lines.

Nearly 4800 steam traps were surveyed under this program with 22% of these, or 1051 traps, identified as "failed" and wasting energy. These failed traps were replaced resulting in an annual energy savings to the university of nearly 100 million pounds of steam, over 10% of the annual usage, and a cost avoidance of nearly $400,000. The total cost to complete this program was $169,100 resulting in a simple payback of five (5) months.

The survey portion of the program involved the generation of a computerized database of all of the traps surveyed. This program compiles all of the information gathered in the field ranging from pipe size to trap type and application in an easy to use program providing a powerful management and planning tool.

The program was an unqualified success in exceeding its goals and management has already committed funds for its continuation.

2.0 INTRODUCTION

Western Michigan University is proud to submit their 1989 Steam Trap Survey and Maintenance Program to the American Association of State Colleges and Universities (AASCU) for recognition under their Model Programs Inventory Project.

The following report, based on the requested format, details how this program was organized, implemented and results achieved. Tremendous benefits in terms of energy reduction and cost savings have already been realized as a result of this program.

While the testing and maintenance of steam traps by itself is nothing new, the way this program was applied here at Western was, we feel, very innovative and based on the successful results achieved, worthy of recognition.

It was innovative in the sense that it went well beyond the maintenance procedures and methodology used by Western in the past to a totally different, systematic approach that incorporated the capabilities of the computer to create a large database of information that can be used as a powerful planning tool for resource and capital management.

We think the approach used here could easily be replicated at other institutions having steam systems with comparable results.

3.0 BACKGROUND

The various heating and steam requirements of over six million square feet of buildings on the campus of Western Michigan University are served through a steam supply and condensate return system. The steam for this system is generated from a coal fired Power Plant presently owned and operated by the Kalamazoo Regional Psychiatric Hospital and supplied to Western at a gauge pressure of 60 PSIG and then reduced in the buildings as required. Almost 90% of the total steam supplied to Western goes to 66 buildings on the West Campus through a distribution network consisting of approximately 9 miles of buried steam and condensate lines. The balance is supplied to 17 buildings on East Campus through a similar 1 1/2 mile distribution network.

Western uses, on average, approximately 800 million pounds of steam per year to heat its buildings, provide hot water and, in some instances, generate air conditioning through absorption chillers. For last fiscal year (July 88 through June 89), WMU used a record 856.6 million pounds of steam at a total cost of $3,127,000 at an average rate of $3.65 per 1000 pounds of steam.

Management naturally questioned if we were using the steam energy we purchased as efficiently as possible and what methods might be implemented for reducing energy use and cost.

In 1988, Western had instituted a pilot program for the testing and maintenance of steam traps on the steam systems in several of its buildings. A steam trap is a device used to permit the removal of condensate from a steam line while at the same time preventing the passage of live steam from this same line from entering the condensate return system. A steam trap that has failed and is "blowing-through" is allowing steam to pass directly from the steam main to the condensate return system thus in effect short circuiting the steam supply system and preventing the end user from realizing its full heating potential.

The energy associated with this steam is basically "wasted" since the boiler still sees this as "load" and burns additional primary fuel, coal in this case, to satisfy this load. The energy cost associated with this steam loss can be quite substantial. For example, under the pilot program, 206 steam traps in our athletic building were surveyed and tested. Of these traps, nearly 20% were identified as failed and "blowing-through" resulting in an annual energy loss of 5.5 million pounds of steam at a cost of $21,000 for this building alone. Similar results were achieved for the other buildings under this pilot program.

Based on the tremendous potential for energy savings established under the pilot program, management expanded the program to encompass the entire campus. This program is the basis for this application.

4.0 DESCRIPTION

Beginning in April 1989 Western Michigan University implemented an ambitious steam trap maintenance program with the following three goals to be accomplished within one year:

1. To have surveyed all of the steam traps on the entire campus steam system.
2. To have identified and replaced all of the failed steam traps on the entire steam system.
3. To have updated our records and the Armstrong Steam Trap Computer Program.

In order to accomplish these goals in the required time frame WMU purchased the services of a steam system technician from Merlo Steam Equipment Company to conduct the steam trap surveys and implement the Armstrong Steam Trap Computer Program. In addition to this individual, Western committed the services of two pipe fitters from its Utility Maintenance Shop, full time, to this program until its completion. Generally, one fitter would assist the technician in conducting the trap surveys while the other replaced traps that were identified as "failed."

The entire program was under the supervision of the facilities mechanical engineer.

4.1 PROGRAM COMPONENTS :

A. STEAM TRAP SURVEY :

Prior to conducting a steam trap survey in a building the engineer and technician first review the steam system drawings for that particular building according to pressure (high vs low), zoning (if there is more than one pressure reducing station), and use (process, equipment, heating, etc.). The importance of this first step cannot be overemphasized. We are striving to educate our maintenance personnel to understand the entire "system" and not just particular components. We feel this approach will help our personnel realize not just how a particular trap functions but how and why that trap is being applied.

This approach is a departure from our initial steam trap surveys where we would record trap data without regard to how the trap functioned as part of the entire system. In addition to surveying traps, other problems in the steam system ranging from leaks, malfunctioning control valves, etc., were noted and addressed. The actual testing of the steam trap itself was performed using either a sonic tester that can sense the steam blowing through, or when available, a test port that provided a visual indication of trap performance.

This "system" approach to our survey program provides a sound,

consistent method that can be successfully applied in every building and system and helps build the knowledge and understanding needed for the successful implementation of the computerized steam trap program.

B. STEAM TRAP COMPUTER PROGRAM:

One of the primary goals of the program was the development and application of the Armstrong Steam Trap Computer Program. This is a versatile, powerful, easy-to-use computer program that literally "does it all." This program contains the data base from the actual field surveys that record trap size, type, application, piping, location, etc. The field survey is the cornerstone of this entire program. It is critical that good, accurate data be correctly gathered in the field to be of any use. This is why a trained technician from Merlo Steam is used to conduct these surveys along with one of our fitters so that he in turn can learn proper survey procedures and gain "in-house" knowledge. The technician from Merlo Steam has been thoroughly trained and schooled in steam systems and surveys through the educational facilities and programs at Armstrong Machine Works in Three Rivers, Michigan.

Information for this trap is easily entered into the data base. From here, combinations of reports are easily produced. It will automatically compute the energy cost of the failed steam traps

either totally, by building, application, type, etc. Several examples of the various reports are included in the appendix. The Armstrong Steam Trap Computer Program utilizes either the Symphony or D-BASE III software and can operate on any IBM or IBM compatible computer having at least 512K of memory. A hard disk drive is recommended. Complete installation and operating instructions are provided by Armstrong.

I cannot say enough about this program and the people from Armstrong Machine Works and Merlo Steam who have been very helpful in seeing it successfully applied here at Western.

C. STEAM TRAP INSTALLATION:

Once a steam trap has been identified as "failed" (either blowing through or cold-plugged) a flag is placed on it in the field and this information then recorded in the database and marked on the floor plans. An order is generated for either a new trap or replacement part. A trap repair report is generated by the computer detailing location of the failed trap and what actions are required. The replacement trap is installed according to our standard trap installation detail (see appendix A-1). Every effort is made to install a test port on the steam trap to provide a visual indication of steam trap performance. This provides the most positive indication of trap performance.

4.2 PROJECT COST

A project budget of $150,000 was set up to encompass the three categories of costs that would comprise this project.

A. C O N T R A C T E D S E R V I C E S :

Western engaged the services of a trained steam technician from Merlo Steam Equipment Company to accomplish the earlier stated goals. A total of 4781 steam traps were surveyed under this program. These were comprised of 4644 building steam traps, 47 steam traps on the high pressure 60 PSIG distribution system, and 90 traps in the Power Plant. The total contract service cost to survey and test these traps and enter them into the computer program was $62,320 based on a total of 1660 hours. This equates to an average survey cost per trap of $13.00, and an average hourly rate for the steam technician of $37.50.

B. M A T E R I A L :

Of the total 4781 traps surveyed on the entire campus, including the Power Plant, 1051 or 22% were identified as "failed" and in need of replacement. The total material cost to replace these traps was $55,826. This equates to an average material cost per trap of $53.11. This cost included any nesessary fittings such as valves, strainers, etc., in addition to the trap itself.

C. INSTALLATION:

The installation cost primarily involves the labor cost of the two on-staff maintenance pipe fitters whose time has been committed to this project. Their labor cost is charged out at the rate of $27 per hour. The total WMU labor cost to install the failed steam traps was $45,360 based on a total of 1680 hours. This equates to an average installation cost of $43.15 per trap.

D. MISCELLANEOUS:

There were various miscellaneous charges associated with the cost of this project ranging from asbestos removal to reprinting building drawings. The total amount of these costs were $5,608.

D. SUMMARY:

To summarize, the total project cost to complete this project and the three earlier stated goals including labor, material, contracted services and miscellaneous was $169,114.

Detailed results of the program are shown in appendix B.

4.3 ENERGY COST AVOIDANCE

When a steam trap is tested through either our sonic tester or visually through a test port and is determined to be "blowing-through" it is labeled as failed and is replaced as soon as possible. As stated earlier, a steam trap that is blowing through is one that is not "trapping" the steam ahead of it and allowing it to condense and give up its heat of vaporization, generally 970 British Thermal Units (BTU's) per pound of steam. This heat of vaporization is necessary for heat transfer equipment such as heating coils, heat exchangers, etc., to function properly and provide adequate heat and comfort for building occupants. A trap that is "blowing-through" is passing steam directly from the supply main into the condensate return system without first condensing and giving up its heat of vaporization. This still represents a "load" on the boilers that Western pays for even though it is not receiving its full heating benefit and the coal burned to generate this steam is wasted. Also, of growing concern is the effect of the additional products of combustion going into the atmosphere such as sulfur dioxide that were generated unnecessarily to meet this "load."

The intent of this program was to identify those traps that are wasting steam energy and replace them with ones that will "trap" the steam and utilize its energy content. This will ultimately be reflected back at the boilers as a reduction of "load."

To calculate the energy cost associated with this steam loss the Armstrong Computer Program Utilizes a sophisticated algorithm that takes into account the steam pressure, heat content, time in service, type of trap and rate to arrive at an accurate cost of the energy being lost. Through this program, the calculated amount of steam "blowing-through" the steam traps on the entire steam system at Western, including the Power Plant, was over 100 million pounds per year, representing an additional estimated annual energy cost to the university and Power Plant of almost $400,000, based on an average steam cost of $3.65 per 1000 pounds of steam. This is over 10% of Western's total annual steam budget.

C A L C U L A T I O N O F S I M P L E P A Y B A C K :

The figure of $399,500 represents the total additional annual energy cost both institutions would have paid if the failed steam traps had not been replaced. Since all the traps identified as failed have been replaced, this figure now represents the energy cost avoidance for one year. The total cost to implement this program and save this energy was $169,114. Therefore, the simple payback period for this program is $169,114 divided by $399,500 per year which equals 0.42 years or approximately 5 months.

5.0 RESULTS

When the budget for this project was initially established it was a guess as to how many traps there were, how many would have to be replaced and what problems would be encountered. The budget at the time was set at $150,000 and based on a total of 3200 traps being surveyed and approximately 400 traps being replaced.

At the conclusion of the program in mid-February of 1990, almost 4800 steam traps were surveyed, tagged and logged into the computer. This was 50% more than was originally estimated. In addition, over 1000 traps were replaced, more than double what was originally estimated. All of this was still accomplished within the given time frame and only 10% over budget. Given this additional work and cost the program still paid for itself in under 6 months.

Western is also starting to see actual reductions in steam usage from the efforts made under this program. Included in appendix C is a steam use report showing current fiscal year use compared with the previous year. Through April, Western steam use was down 9% as compared with the previous year and 7.3% when compared on a degree-day basis. When further evaluated on a degree-day basis, this represents an actual reduction in use of approximately 54 million pounds, and when multiplied by the current year cost of steam production of $3.91/MLBS (versus

$3.65/MLBS last year) represents a cost avoidance to the university of over $200,000. This compares favorably with the estimates generated from the Armstrong Computer Program which predicted a 10% reduction, especially when the time variable of all the traps not being replaced until February of 1990 is factored in.

There are many additional benefits associated with this energy reduction besides the obvious dollar savings that are not readily apparent. For example, reducing the "demand" side requirements of our system could ultimately lead to significant cost savings when it comes to installing new steam generating equipment that does not have to be sized as large to meet the "load." Also, by reducing steam use, the amount of coal burned is reduced, approximately 2000 tons in this case, and therefore the amount of pollutants entering the atmosphere as well.

Perhaps the most important accomplishment of the program was the establishment of a computerized data base of all the steam traps on campus. There are not many steam system operations around where the operator can tell you exactly how many steam traps there are, what kind they are, how they are being applied, etc. This provides us with a powerful planning and informational tool not previously available. For example, with this information we can now better manage our inventory. Prior to this we carried thousands of dollars of steam traps in our stores unnecessarily.

We now have the necessary information available to eliminate this backlog and reduce the inventory to levels commensurate with our needs. Also, we can now more effectively utilize our maintenance personnel. For example, it is more cost effective to schedule our fitters to change one drip trap costing thousands of dollars a year in energy losses ahead of changing a number of radiator traps costing less than a hundred dollars a year. The applications and uses of this program are virtually limitless and we are just beginning to tap its potential.

No project is ever completed without encountering some problems and this one was no exception. Problems that were encountered were relatively minor and generally of a coordinational nature. The major problem was access to buildings or rooms which would require additional time and effort. Special arrangements would occasionally have to be made for starting up steam systems for testing and shutting down for installation. Asbestos removal was always a concern and occasionally had to take place. Also, some areas that had to be accessed were defined by our Safety Department as "confined spaces" requiring special arrangements. The impact of these various problems were minimized with proper planning and coordination.

Special mention should also be made of the active support and encouragement from management that helped the program achieve the success it did.

6.0 CONCLUSIONS

The results of this program were quite successful. So much so, that management has already committed funds for its continuation and we are presently well into "Cycle II." We have established similar goals for Cycle II as with Cycle I with the exception of a shorter time frame and smaller budget reflecting the fewer number of failed traps expected to be encountered.

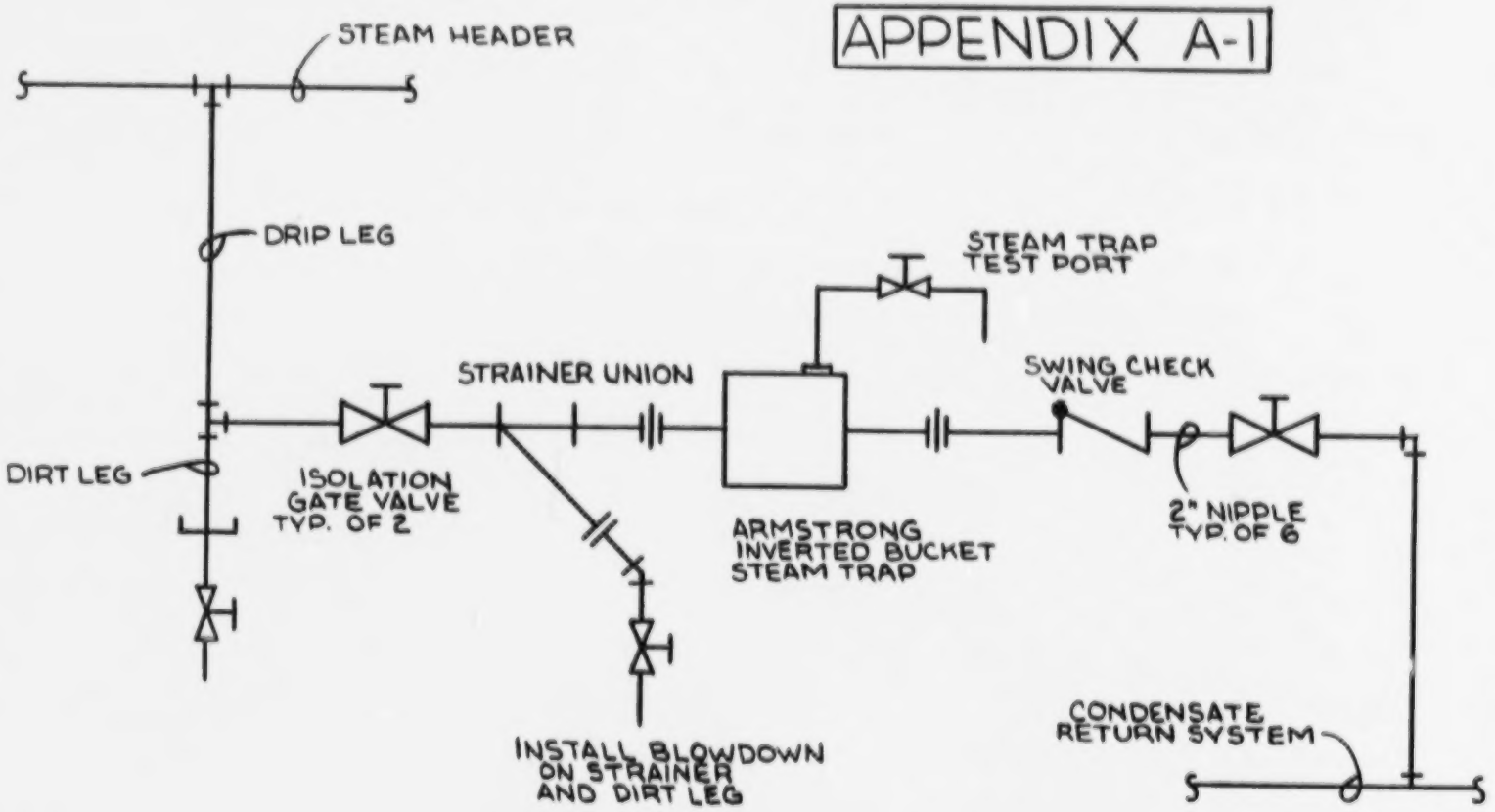
In addressing the question of how viable it would be to replicate this program at other instituitions, providing they also have a steam system, we would respond with an unqualified "yes." The size of the system is irrevelant. Even if the system is much smaller than ours, it only takes one drip trap blowing through to burden you unnecessarily with thousands of dollars of extra energy costs.

What was implemented at Western was a "methodology" and not a particular apparatus or device that may or may not be applicable at other institutions. The approach we used and the methodology we implemented are all easily transportable and should produce equally successful results wherever they are applied.

APPENDIX

A	STEAM TRAP INSTALLATION DETAIL	A - 1
B	STEAM TRAP SURVEY SUMMARY RESULTS:	
	1. TRAP FAILURE AND COST	B - 1
	2. TYPES OF STEAM TRAPS	B - 2
	3. TRAP MANUFACTURERS AND MODELS	B - 3
	4. PROGRAM COST SUMMARY	B - 4
	5. PROGRAM ENERGY SAVINGS	B - 5
C	WMU STEAM ENERGY USE DATA:	
	1. WMU 1989/90 STEAM REPORT	C - 1
	2. GRAPHS OF WMU STEAM USE -	
	88/89 vs 89/90 - MONTH	C - 2
	88/89 vs 89/90 - YEAR TO DATE	C - 3
D	ARMSTRONG STEAM TRAP COMPUTER REPORTS:	
	1. ABBREVIATIONS USED FOR REPORTS	D - 1
	2. STEAM LOSS REPORT	D - 2
	3. HISTORY DATA	D - 3
	4. CONDITION REPORT	D - 4
	5. LOG SHEET DATA	D - 5
E	REFERENCES	E - 1

APPENDIX A-1



NOTES:

1. PIPE MATERIAL – SCHED 40 UNLESS OTHERWISE NOTED.
2. DRIP LEG SAME SIZE AS HEADER DIAMETER UP TO 4". ABOVE 4" DRIP LEG SHOULD BE 1/2 HEADER SIZE BUT NEVER LESS THAN 4".
3. ALL PIPE FITTINGS THREADED AND SIZED FOR TRAP CONNECTION. SIZE WILL VARY FROM 1/2" UP TO 2" BASED ON PARTICULAR TRAP.

PROJECT NO. R-9246
SHEET NO. 1 of 1
PRELIMINARY ☐ CONSTRUCTION ☒ FINAL ☐

STEAM TRAP INSTALLATION DETAIL

WESTERN MICHIGAN UNIVERSITY
PHYSICAL PLANT
KALAMAZOO, MICHIGAN

DATE 10/24/1985

APPROVED

1989 STEAM TRAP SURVEY SUMMARY

I. BUILDING TRAP FAILURE, PERCENT & COST

TRAP APPLICATION	NO. OF TRAPS	QTY. FAILED	PERCENT FAILED	ENERGY COST-$
A. DRIP TRAPS				
1. FLOAT & THERMOSTATIC	655	227	34	116,420
2. INVERTED BUCKET	105	14	13	20,830
3. THERMOSTATIC	228	52	22	4,790
4. ORIFICE	7	7	100	2,590
TOTAL =	995	300	30	144,630
B. COIL TRAPS				
1. FIN TUBE HEATERS	1431	365	25	25,020
2. RADIATORS	765	191	24	11,850
3. UNIT VENTILATORS	464	64	13	9,910
4. AIR HANDLERS	537	62	11	14,510
5. UNIT HEATERS	111	12	9	2,820
TOTAL =	3308	694	20	64,110
C. PROCESS TRAPS				
1. HEAT EXCHANGERS	236	12	5	17,430
2. JACKETED KETTLES	35	12	34	5,310
3. HUMIDIFIERS	33	1	3	230
4. ABSORPTION CHILLERS	23	2	8	6,910
5. MISCELLANEOUS	14	0	0	0
TOTAL =	341	27	8	29,880
TOTAL FOR ALL BLDG. TRAPS =	4644	1021	22	$238,620

1989 STEAM TRAP SURVEY SUMMARY

II. TYPES OF BUILDING STEAM TRAPS

1. F L O A T & T H E R M O S T A T I C

A) ILLINOIS -		1221
B) TRANE -		172
C) ARMSTRONG -		89
D) MISC. -		55
	TOTAL =	1537

2. T H E R M O S T A T I C

A) ILLINOIS -		2205
B) TRANE -		236
C) ARMSTRONG -		13
D) MISC. -		108
	TOTAL =	2562

3. I N V E R T E D B U C K E T

A) ARMSTRONG -		421
B) TRANE -		2
C) ILLINOIS -		1
D) MISC. -		6
	TOTAL =	430

4. O R I F I C E

A) STEAM GUARD -	115

TOTAL FOR ALL BUILDING TRAPS SURVEYED = 4644

1989 STEAM TRAP SURVEY SUMMARY

III. MAJOR TRAP MANUFACTURERS & MODELS

MANUFACTURER	MODEL	TYPE	QUANTITY
ILLINOIS :			
1.	1G	thermostatic.....	1988
2.	3G	thermostatic.....	217
3.	6G	float & thermostatic.....	494
4.	7G	float & thermostatic.....	265
5.	8G	float & thermostatic.....	153
6.	91G	float & thermostatic.....	128
7.	101G	float & thermostatic.....	74
8.	111G	float & thermostatic.....	26
9.	625	float & thermostatic.....	14
10.	NO.30	float & thermostatic.....	34
11.	OTHER	.....	39
		TOTAL =	3432
ARMSTRONG :			
1.	800	inverted bucket.....	228
2.	811	inverted bucket.....	145
3.	812	inverted bucket.....	10
4.	813	inverted bucket.....	7
5.	212	inverted bucket.....	7
6.	213	inverted bucket.....	10
7.	2011	inverted bucket.....	15
8.	15B3	float & thermostatic.....	68
9.	OTHER	.....	27
		TOTAL =	517
TRANE :			
1.	B1	thermostatic.....	216
2.	B3	thermostatic.....	18
3.	55AL	float & thermostatic.....	106
4.	66CL	float & thermostatic.....	3
5.	77HL	float & thermostatic.....	28
6.	OTHER	.....	39
		TOTAL =	410
MISCELLANEOUS			285
TOTAL FOR ALL BUILDING TRAPS SURVEYED =			4644

1989 STEAM TRAP SURVEY SUMMARY

IV. PROGRAM COST SUMMARY

ITEM		$ - AMOUNT
A.	MATERIAL :	
	1. STEAM TRAPS	47,521
	2. WMU STOCKROOM (PARTS, FITTINGS)	8,305
	TOTAL =	55,826
B.	LABOR :	
	1. WMU LABOR (APPROX. 1680 HRS. @ $27/HR)	45,360
C.	CONTRACT SERVICES :	
	1. MERLO STEAM TECHNICIAN (APPROX. 1660 HRS. AT AVG. RATE OF $37.50/HR)	62,320
D.	OTHER :	
	1. BLDG. REPRINTS, DRAWINGS	4,005
	2. ASBESTOS REMOVAL/REINSULATION	827
	3. MISC. PARTS/SUPPLIES	776
	TOTAL =	5,608

TOTAL PROJECT COST = $169,114

1989 STEAM TRAP SURVEY SUMMARY

V. PROGRAM ENERGY AND COST SAVINGS

ITEM	BUILDINGS	STEAM VAULTS	POWER PLANT	TOTAL
1. TOTAL TRAPS	4644	47	90	4781
2. NO. FAILED	1021	13	17	1051
3. % FAILED	22%	28%	19%	22%
4. ENERGY COST-$	238,620	93,300	67,500	$399,420
5. STEAM LOSS:				
A. LBS./HR	8,795	2,911	2,167	13,873
B. LBS./YR	65,375,340	25,561,640	18,493,150	109,430,130

ABBREVIATIONS USED IN ARMSTRONG STEAM TRAP COMPUTER REPORTS

1. TRAP MANUFACTURERS:

ARM = ARMSTRONG
DUN = DUNHAM-BUSH
GES = GESTRA
HOF = HOFFMAN
ILL = ILLINOIS
STI = STICKLE
TRA = TRANE
YAR = YARWAY

2. TRAP TYPE:

T = THERMOSTATIC
B = INVERTED BUCKET
F = FLOAT AND THERMOSTATIC

3. PIPING CONFIGURATION - 1=YES, 0=NO

V-I = VALVE ON INLET
STR = STRAINER
V-O = VALVE ON OUTLET

4. TRAP CONDITION:

BT = BLOW THROUGH
CO = COLD- OUT OF SERVICE
CP = COLD PLUGGED
FL = FLOODED
LK = LEAKING
NT = NOT TESTED (INACCESSIBLE)
OK = GOOD TRAP
UN = UNDETERMINED

5. TRAP APPLICATION:

CL = COIL
DP = DRIP
PS = PROCESS
TR = TRACER

6. TRAP SUPPLY AND DISCHARGE PRESSURES:

P-I = INLET PRESSURE
P-O = OUTLET PRESSURE
C = CONSTANT PRESSURE
M = MODULATING PRESSURE
O = OPEN TO ATMOSPHERE

7. EQUIPMENT TRAP IS APPLIED ON:

AH = AIR HANDLER
AV = AIR VENT
FT = FIN TUBE
HE = HEAT EXCHANGER
HUM = HUMIDIFIER
KET = JACKETED KETTLE
PH = PREHEATER
RAD = RADIATOR
RH = REHEATER
STER = STERILIZER
TH = TANK HEATER
UH = UNIT HEATER

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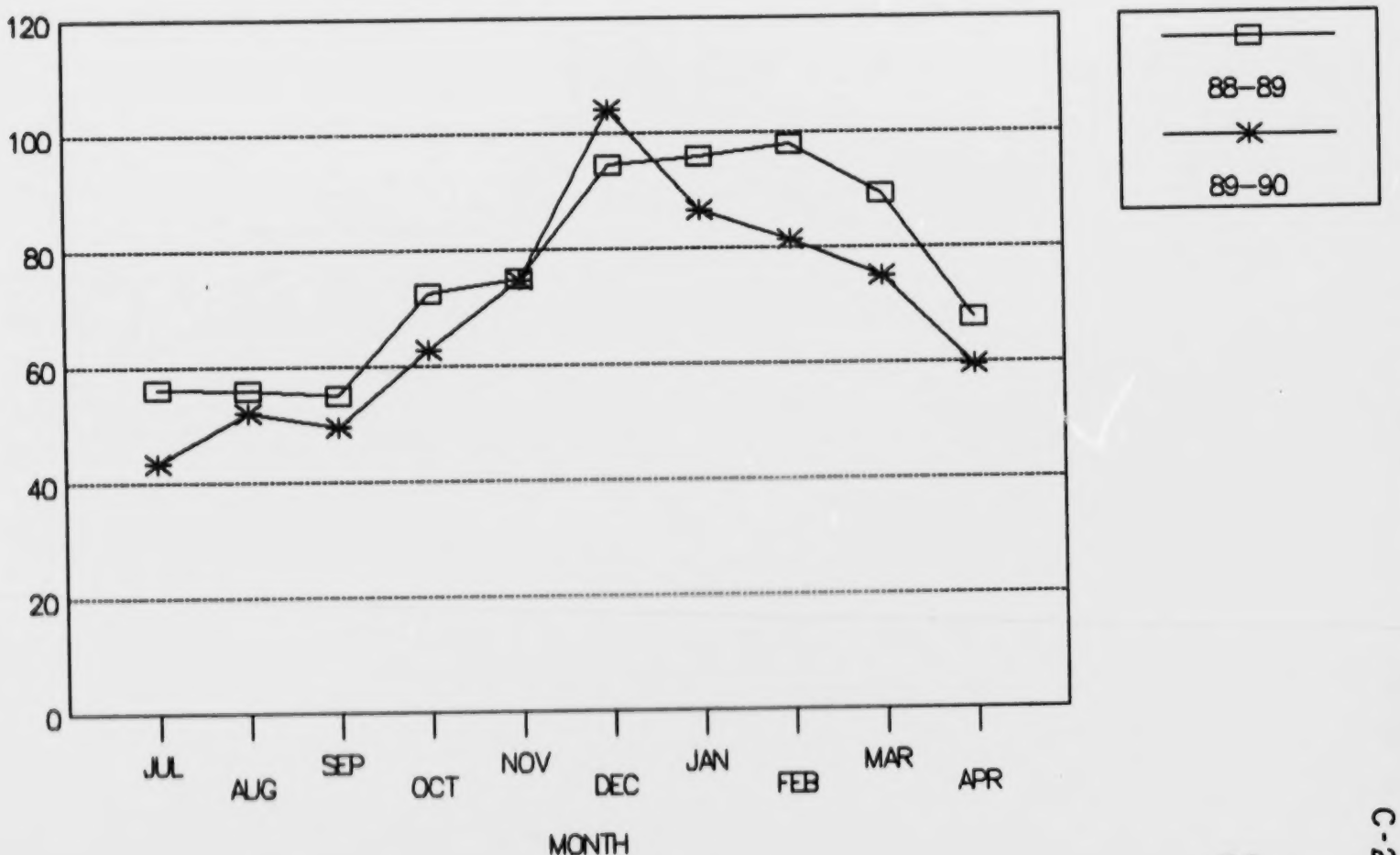
W.N.U. STEAM COST	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	TOTAL
Current Year													
W.N.U. Steam Cost	153,139.72	186,883.02	399,287.33	109,147.27	264,750.93	347,071.86	353,493.48	382,544.72	311,854.19	265,387.88			2,693,398.00
W.N.U. Condensate Penalty	586.57	491.63	589.54	397.52	365.67	650.26	561.73	621.16	594.50	702.30			5,478.88
W.N.U. Total Steam Cost	153,726.29	187,294.65	399,716.87	109,544.79	265,116.60	347,721.32	354,055.21	383,165.88	312,448.69	266,089.38	0.00	0.00	2,698,877.68
W.N.U. Total Steam Cost YTD	153,726.29	341,018.94	740,735.81	850,280.60	1,115,397.20	1,463,118.52	1,817,173.73	2,120,339.61	2,432,788.30	2,698,877.68	2,698,877.68	2,698,877.68	2,698,877.68
W.N.U. Avg. Steam Cost/MLBS YTD	3.543	3.578	5.114	4.894	3.949	3.786	3.841	3.824	3.865	3.917	3.917	3.917	3.917
Previous Year													
W.N.U. Steam Cost	101,776.80	196,210.52	270,738.91	41,541.68	338,571.52	346,876.08	336,317.06	295,521.08	398,327.37	265,877.82	198,221.98	259,715.39	3,117,697.01
W.N.U. Condensate Penalty	227.51	663.14	763.41	749.13	774.69	953.74	970.81	893.54	929.59	854.32	835.10	619.31	9,234.34
W.N.U. Total Steam Cost	102,004.31	196,873.66	279,502.32	42,290.81	339,346.21	347,829.82	337,287.87	296,415.42	399,256.96	266,732.19	199,057.08	260,334.70	3,126,931.35
W.N.U. Total Steam Cost YTD	102,004.31	370,877.97	650,380.29	700,671.10	1,040,017.31	1,387,847.13	1,725,135.00	2,021,550.42	2,420,807.38	2,687,539.57	2,886,596.65	3,126,931.35	3,126,931.35
W.N.U. Avg. Steam Cost/MLBS YTD	3.2411	3.3837	3.9449	2.9264	3.3078	3.3930	3.4161	3.3527	3.4972	3.5105	3.5319	3.6503	3.6503
W.N.U. STEAM USE													
Current Year													
West Campus Steam (MLBS)	39,900.00	48,722.00	46,544.00	55,000.00	65,839.00	92,320.00	76,464.00	72,175.00	65,980.00	52,320.00	0.00	0.00	616,972.00
East Campus Steam (MLBS)	3,489.50	3,192.00	2,999.50	7,014.00	8,935.50	11,739.00	10,164.00	9,285.00	8,942.50	7,322.00			73,083.00
Total W.N.U. Steam Use (MLBS)	43,389.50	51,914.00	49,543.50	62,022.00	74,774.50	104,059.00	86,628.00	81,380.00	74,922.50	59,642.00	0.00	0.00	689,875.00
W.N.U. Steam Use YTD (MLBS)	43,389.50	95,303.50	144,847.00	207,669.00	282,443.50	386,502.50	473,130.50	554,510.50	629,433.00	689,075.00	689,075.00	689,075.00	689,075.00
Previous Year													
West Campus Steam (MLBS)	52,889.00	52,057.00	51,249.00	64,000.00	65,632.00	83,360.00	94,686.00	87,094.00	78,869.50	59,720.00	46,096.00	41,779.00	760,231.50
East Campus Steam (MLBS)	3,265.50	3,759.00	3,675.00	8,540.00	9,340.50	11,256.00	11,287.50	10,067.50	10,375.00	7,952.00	4,844.00	3,216.50	88,286.50
Total W.N.U. Steam Use (MLBS)	56,154.50	55,816.00	54,924.00	72,540.00	74,980.50	94,616.00	105,973.50	97,961.50	89,244.50	67,672.00	51,740.00	44,995.50	856,618.00
W.N.U. Steam Use YTD (MLBS)	56,154.50	111,970.50	166,894.50	239,434.50	314,415.00	409,031.00	515,004.50	602,966.00	692,210.50	759,882.50	811,622.50	856,618.00	856,618.00
W.N.U. STEAM DEG. DAYS													
Deg. Days (heating)	0	0	168	430	895	1,432	1,019	997	832	522	0	0	6,287
Deg. Days YTD	0	0	168	598	1,485	2,917	3,936	4,933	5,765	6,287	6,287	6,287	6,287
Steam MLBS/Deg Days	-----	-----	309.65	146.10	83.55	72.67	85.01	81.62	90.05	114.26	ERR	ERR	109.60
Steam MLBS/Deg Days YTD	-----	-----	905.29	351.98	190.20	132.50	120.21	112.41	109.18	109.60	109.60	109.60	109.60
Prev. year Deg. Days (heating)	0	0	72	651	756	1,150	1,065	1,202	964	563	271	34	6,735
Prev. Year Deg Days YTD	0	0	72	722	1,478	2,636	3,701	4,903	5,867	6,430	6,701	6,735	6,735
Prev Year Steam MLBS/Deg Days	-----	-----	772.58	111.43	99.18	81.71	99.12	81.50	92.58	120.28	190.92	1,323.40	127.19
Prev Year Steam MLBS/Deg Days YTD	-----	-----	2,353.63	331.63	212.73	155.17	136.45	122.98	117.98	118.18	121.12	127.19	127.19
W.N.U. STEAM CONDENSATE													
W. Campus Cond.	13,675.00	26,372.00	23,775.00	41,225.00	54,100.00	69,150.00	55,950.00	48,725.00	43,525.00	26,680.00			403,397.00
W. Condensate Loss	26,225.00	22,350.00	22,759.26	14,583.00	11,739.00	23,170.00	23,514.00	23,450.00	22,455.00	25,720.00	0.00	0.00	215,975.00
W.C. Per-Cent Loss	65.73%	45.87%	48.92%	26.13%	17.83%	25.10%	26.03%	32.49%	34.03%	49.16%	ERR	ERR	34.87%
E. Campus Cond.	3,897.50	3,339.00	2,667.50	3,528.00	4,053.00	5,351.50	5,145.00	4,420.50	4,375.00	4,219.50			40,936.50
E. Campus Condensate Loss	392.00	-147.00	392.50	3,486.00	4,882.50	6,387.50	5,819.00	4,784.50	4,567.50	3,202.50	0.00	0.00	32,966.50
E.C. Per-Cent Loss	11.23%	-4.61%	13.07%	49.70%	54.64%	54.41%	49.38%	51.98%	51.08%	43.74%	ERR	ERR	45.16%
W.N.U. STEAM BTU													
W.N.U. Steam BTU's (x10^6)	46,906.57	57,049.35	52,853.07	65,875.44	77,897.98	108,779.91	93,624.66	84,819.38	78,307.98	63,383.38			726,997.17
W.N.U. Steam BTU's YTD	46,906.57	103,955.92	156,808.99	222,684.43	300,582.32	409,362.22	502,986.89	587,806.26	663,114.17	726,997.17	726,997.17	726,997.17	726,997.17
Previous Year Steam BTU's YTD	58,806.69	110,906.69	179,778.31	256,778.31	334,618.39	417,415.39	479,718.39	544,298.39	599,715.42	652,626.67	699,226.27	818,731.73	818,731.73

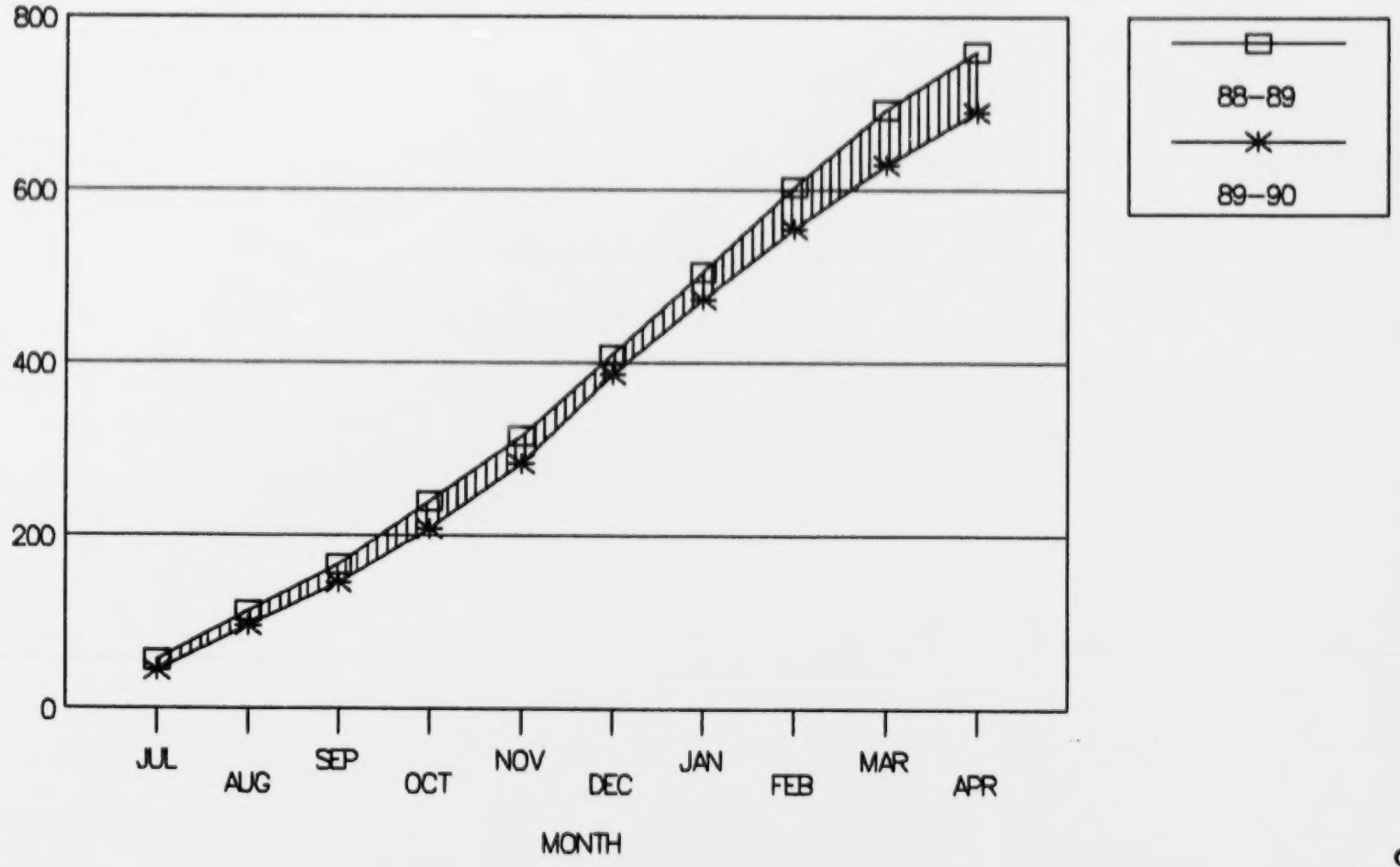
WMU STEAM USE –MONTH

CURRENT YEAR vs. PREVIOUS YEAR



WMU STEAM USE YTD

CURRENT YEAR vs. PREVIOUS YEAR



REPORT DATE 05/16/90

WMU MCCRACKEN HALL
STEAM LOSS REPORT

Cost of Steam is 4.50 Dollars/1000 lbs

TAG	MFG	MODEL	MONTHS IN USE	STEAM LOSS (LBS/HR)	STEAM LOSS (ANNUAL)	Dollars LOSS (ANNUAL)
27N-34	ILL	101G	6	102	446,760	$2,010
27-036	ILL	NO.30	12	45	394,200	$1,774
27-032	TRA	1620	12	18	157,680	$ 710
27-022	TRA	NO.1	12	18	157,680	$ 710
27-083	STI	NO.115	12	18	157,680	$ 710
27-082	STI	NO.115	12	18	157,680	$ 710
27-102	ILL	8G	8	22	128,480	$ 578
27-016	ILL	6G	12	11	96,360	$ 434
27-084	ILL	6G	12	11	96,360	$ 434
27-100	ILL	6G	12	11	96,360	$ 434
27-088	ILL	6G	8	11	64,240	$ 289
27-007	DUN	10WA	8	11	64,240	$ 289
27-029	TRA	55	12	5	43,800	$ 197
27-086	ILL	1G	12	3	26,280	$ 118
27-207	ILL	1G	8	3	17,520	$ 79
27-202	ILL	1G	8	3	17,520	$ 79
27-222	ILL	1G	8	3	17,520	$ 79
27-221	ILL	1G	8	3	17,520	$ 79
27-219	ILL	1G	8	3	17,520	$ 79
27-140	TRA	B1	8	3	17,520	$ 79
27-139	TRA	B1	8	3	17,520	$ 79
27-127	ILL	1G	8	3	17,520	$ 79
27-169	ILL	1G	8	3	17,520	$ 79
27-167	ILL	1G	8	3	17,520	$ 79
27-181	ILL	1G	8	3	17,520	$ 79
27-177	ILL	1G	8	3	17,520	$ 79
27-193	ILL	1G	8	3	17,520	$ 79
27-146	ILL	1G	8	3	17,520	$ 79
TOTALS	TRAPS:	28		346	2,333,080	$ 10,503

TAG NUMBER	MFG	MODEL	CONN TYPE	SUPL P-I		DISCH P-O		APPL V-I	STR V-O		COND
71-152	ILL	3G	T 3/4	M	5	C	0	CL	0	0	OK

History Date: 06/19/89
History Action: REPLACED 3G BELLOWS & SEAT WITH ARM SILVER NUGGET

HISTORY COMMENT: NTPA

71-155	ARM	811	B 1	C	20	C	0	DP	1	1	OK

History Date: 04/21/89
History Action: REPLACED 7G ILL WITH ARM #811 1" CONN 70# ORIFICE

HISTORY COMMENT: 1/4" TEST PORT INSTALLED

71-161	ILL	1G	T 1/2	M	5	C	0	CL	0	0	OK

History Date: 04/18/89
History Action: REPLACED BELLOWS & SEAT IN 1G WITH ARM SILVER NUGGET

HISTORY COMMENT: NO TEST PORT AVAILABLE

71-165	ILL	1G	T 1/2	M	5	C	0	CL	0	0	OK

History Date: 04/18/89
History Action: REPLACED BELLOWS & SEAT IN 1G WITH ARM SILVER NUGGET

HISTORY COMMENT: NO TEST PORT AVAILABLE

71-172	ILL	3G	T 3/4	M	5	C	0	CL	0	0	OK

History Date: 06/19/89
History Action: REPLACED ILL 3G BELLOWS & SEAT WITH ARM SILVER NUGGET

HISTORY COMMENT: NTPA

71-175	ARM	811	B 1	C	5	C	0	DP	1	1	OK

History Date: 04/21/89
History Action: REPLACED 7G ILL WITH ARM #811 1" CONN 80# ORIFICE

HISTORY COMMENT: 1/4" TEST PORT INSTALLED

TAG	LOCATION	MFR MODEL	P-I	APPL
	****CONDITION BT ****			
44-01	KOHRMAN MECH RM.	ILL 30	60	DP
44-24	KOHRMAN 1109	ILL 8G	12	CL
44-27	KOHRMAN 1092	ILL 91G	12	CL
44-33	KOHRMAN WOODSHOP 1089	ILL 91G	12	CL
44-50	KOHRMAN 2090 IN CEILING	ILL 91G	12	CL
	****CONDITION CO ****			
44-41	KOHRMAN 1082	ILL 1G	12	CL
44-42	KOHRMAN 1082	ILL 1G	12	CL
44-43	KOHRMAN 2083	ILL 1G	12	CL
44-44	KOHRMAN MENS ROOM	ILL 1G	12	CL
44-48	KOHRMAN 2114A	ILL 7G	12	CL
44-55	KOHRMAN 3052 3RD FLOOR HALLWAY IN CEILING	ILL 6G	12	PS
44-56	KOHRMAN 3RD FLOOR HALLWAY IN CEILING	ILL 6G	12	PS
	****CONDITION CP ****			
44-14	KOHRMAN TUNNEL	ILL 710	60	DP
44-31	KOHRMAN WOODSHOP 1086	ILL 91G	12	CL
	****CONDITION NT ****			
44-05	KOHRMAN MECH RM.	ILL 101G	12	PS
44-06	KOHRMAN MECH RM.	ILL 101G	12	PS
44-07	KOHRMAN MECH RM.	ILL 101G	12	PS
	****CONDITION OK ****			
44-02	KOHRMAN MECH RM.	ILL 8G	12	DP
44-03	KOHRMAN MECH RM.	ILL 6G	12	DP
44-04	KOHRMAN MECH RM.	ILL 91G	12	PS
44-08	KOHRMAN MECH RM.	ILL 625	12	PS
44-09	KOHRMAN MECH RM.	ILL 625	12	PS
44-10	KOHRMAN MECH RM. BY TUNNEL DOOR NEXT TO LADDE	ARM 801	60	DP
44-11	KOHRMAN MECH RM.	ILL 8G	12	CL
44-12	KOHRMAN MECH RM.	ILL 8G	12	CL
44-13	KOHRMAN MECH. ROOM BASEMENT	ILL 6G	12	DP
44-15	KOHRMAN TUNNEL	ARM 800	12	DP
44-16	KOHRMAN TUNNEL	ILL 101G	12	PS
44-17	KOHRMAN AUTO LAB	ILL 91G	12	CL
44-18	KOHRMAN 1118	ILL 6G	12	DP
44-19	KOHRMAN 1118	ILL 91G	12	CL
44-20	KOHRMAN 1118	ILL 6G	12	DP
44-21	KOHRMAN 1118	ILL 91G	12	CL
44-22	KOHRMAN 1120	ILL 8G	12	CL
44-23	KOHRMAN 1120	ILL 91G	12	CL
44-25	KOHRMAN 1109	ILL 8G	12	CL
44-26	KOHRMAN 1083	ILL 8G	12	CL
44-28	KOHRMAN 1092	ILL 101G	12	CL
44-29	KOHRMAN TRANSFORMER ROOM	ARM 811	0	PS
44-30	KOHRMAN TRANSFORMER ROOM	ARM 811	0	PS
44-32	KOHRMAN WOODSHOP 1086	ARM 800	12	PS
44-34	KOHRMAN WOODSHOP 1098	ARM 800	12	CL
44-35	KOHRMAN 2ND FLOOR 2103	ILL 91G	12	CL
44-36	KOHRMAN 2ND FLOOR 2098	ILL 8G	12	CL

TAG NUMBER	MFG	MODEL	TYPE	CONN	SUPL P-I	DISCH P-O	APPL V-I	STR V-O	COND
31-43	TRA	B1	T	1/2	M 12	C 0	CL 0	0 0	BT

ELEVATION: 1 feet Equipment: FT MONTHS IN USE: 8
LOCATION: KANLEY HALL IN CHAPEL
COMMENTS: NTP
RECOMMEND: REPLACE W\ ILL 1G TRAP
TEST FREQUENCY: 1 Times per year
STEAM LOSS (lbs/hr) 3 DOLLAR LOSS (annual) $79

TAG NUMBER	MFG	MODEL	TYPE	CONN	SUPL P-I	DISCH P-O	APPL V-I	STR V-O	COND
31-47	TRA	B1	T	1/2	M 12	C 0	CL 0	0 0	BT

ELEVATION: 1 feet Equipment: FT MONTHS IN USE: 8
LOCATION: KANLEY HALL IN CHAPEL
COMMENTS: NTP
RECOMMEND:
TEST FREQUENCY: 1 Times per year
STEAM LOSS (lbs/hr) 3 DOLLAR LOSS (annual) $79

TAG NUMBER	MFG	MODEL	TYPE	CONN	SUPL P-I	DISCH P-O	APPL V-I	STR V-O	COND
31-55	TRA	B1	T	1/2	M 0	C 0	CL 0	0 0	BT

ELEVATION: 10 feet Equipment: FT MONTHS IN USE: 8
LOCATION: KANLEY IN CHAPEL
COMMENTS: NTP
RECOMMEND: REPLACE W\ ILL 1G TRAP
TEST FREQUENCY: 1 Times per year
STEAM LOSS (lbs/hr) 3 DOLLAR LOSS (annual) $79

TAG NUMBER	MFG	MODEL	TYPE	CONN	SUPL P-I	DISCH P-O	APPL V-I	STR V-O	COND
31-56	TRA	B1	T	1/2	M 12	C 0	CL 0	0 0	BT

ELEVATION: 10 feet Equipment: FT MONTHS IN USE: 8
LOCATION: KANLEY IN CHAPEL
COMMENTS: NTP
RECOMMEND: REPLACE W\ ILL 1G TRAP
TEST FREQUENCY: 1 Times per year
STEAM LOSS (lbs/hr) 3 DOLLAR LOSS (annual) $79

TAG NUMBER	MFG	MODEL	TYPE	CONN	SUPL P-I	DISCH P-O	APPL V-I	STR V-O	COND
31-57	TRA	B1	T	1/2	M 12	C 0	CL 0	0 0	BT

ELEVATION: 10 feet Equipment: FT MONTHS IN USE: 8
LOCATION: KANLEY IN CHAPEL
COMMENTS: NTP
RECOMMEND: REPLACE W\ ILL 1G TRAP
TEST FREQUENCY: 1 Times per year
STEAM LOSS (lbs/hr) 3 DOLLAR LOSS (annual) $79

TAG NUMBER	MFG	MODEL	TYPE	CONN	SUPL P-I	DISCH P-O	APPL V-I	STR V-O	COND
31-58	TRA	B1	T	1/2	M 12	C 0	CL 0	0 0	BT

ELEVATION: 10 feet Equipment: FT MONTHS IN USE: 0
LOCATION: KANLEY IN CHAPEL
COMMENTS: NTP
RECOMMEND: REPLACE W\ ILL. 1G TRAP
TEST FREQUENCY: 1 Times per year
STEAM LOSS (lbs/hr) 3 DOLLAR LOSS (annual) $0

TAG NUMBER	MFG	MODEL	TYPE	CONN	SUPL P-I	DISCH P-O	APPL V-I	STR V-O	COND
31-59	TRA	B1	T	1/2	M 12	C 0	CL 0	0 0	BT

ELEVATION: 10 feet Equipment: FT MONTHS IN USE: 8
LOCATION: KANLEY IN CHAPEL
COMMENTS: NTP
RECOMMEND: REPLACE W\ ILL 1G TRAP
TEST FREQUENCY: 1 Times per year
STEAM LOSS (lbs/hr) 3 DOLLAR LOSS (annual) $79

REFERENCES

FOR FURTHER INFORMATION ON THE ARMSTRONG STEAM TRAP COMPUTER PROGRAM, OR ANY OF THE STEAM MANAGEMENT SERVICES THAT ARMSTRONG OFFERS, PLEASE CONTACT :

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816 MAPLE STREET

THREE RIVERS, MI 49093

PHONE : (616) 273-1415